2004 Director's Discretionary Fund Proposal

Principal Investigator: John Bolton/420
Co-Investigators: Kurtis Thome/UAZ
Proposal Title: Vicarious Calibration of Hyperspectral Sensors

Background:

Hyperspectral sensors are capable of acquiring an enormous amount of information. Included in a typical hyperspectral scene are many so-called "pseudo-invariant targets". These targets have spectral and spatial features that do not change significantly over time. The use of pseudo-invariant targets and of well characterized ground truth sites to calibrate spaceborne sensors is called "vicarious calibration".

This proposal seeks to investigate the feasibility of using vicarious calibration to calibrate, verify and characterize a hyperspectral sensor. This approach differs from the traditional approach in that the normal data acquisition process, rather then special "calibration campaigns" would be used to provide the vicarious calibration information. In other words, the instrument calibration process would be integrated into the normal data acquisition process, and it would be continuous.

We expect that the application of vicarious calibration, as described above, to a hyperspectral sensor will eliminate the need for any on-board calibration capability. Not only will the vicarious calibration process provide all the instrument calibration information that is needed, it will also provide information that can be used to develop empirical retrieval algorithms.

Objectives:

1) Review the vicarious calibration literature and contact vicarious calibration experts
2) Evaluate existing vicarious calibration technologies and capabilities
3) Investigate applicability and advantages of current vicarious calibration technologies to hyperspectral sensors
4) Explore and develop new statistical methods for vicarious calibration
5) Evaluate vicarious calibration versus traditional calibration methods
6) Investigate and propose alternative instrument technology to optimize the use of vicarious calibration

Research and Development Plan:

1) Review literature and contact calibration experts (3 months)
2) Define current vicarious calibration state-of-the-art (1 month)
3) Formulate application plan (2 months)
4) Develop "strawman" techniques for vicarious calibration (2 months)
5) Evaluate vicarious calibration techniques (2 months)
6) Compare vicarious calibration to traditional calibration (1 month)
7) Compile information and prepare report on findings (1 month)

Context:

This proposed project is innovative and also high risk. It is innovative in that it uses accepted techniques in a new and more extensive fashion. The project risk is not primarily in the availability of technology and applications, but in the acceptance of this approach by the remote sensing community and NASA in particular. This DDF would allow the PI to demonstrate the utility and effectiveness of vicarious calibration for hyperspectral sensors, and prepare for further investigations and development of the principle.

The project fits perfectly with Goddard's Mission as it seeks to develop an innovative technology for Earth science measurements from space that will help "develop and maintain advanced information systems for the display, analysis, archiving and distribution of space and Earth science data". In addition this research could lead to technologies that could help to "develop National Oceanic and Atmospheric Administration (NOAA) satellite systems that provide environmental data for forecasting and research".

Innovation Summary:

Calibration of spaceborne sensors has always been a difficult and sometimes controversial business. By relying entirely on ground truth, the users of the remotely sensed information will always have an absolute reference on which to base their analyses. This will eliminate the "middleman"; the modeler or the retrieval algorithm developer. Developing the concept of exclusive vicarious calibration for hyperspectral sensors would put Goddard at the forefront of the establishment of an exceptionally powerful remote sensing technology. The principles of vicarious calibration have been known, and the application studied for years. The idea to rely on vicarious calibration exclusively is new. This project will be successful if the remote sensing community sees the value of using vicarious calibration exclusively. The major risk is that the community will not be willing to change, or even give up an approach to remote sensing that it has used for the past 30 years.

Budget:

• Analytical Software	$6,500
• Supplemental Hardware and associated Software	$9,000
• Travel	3,500
• Total	$19,000

PI Time	0.25 man-years
Co-I Time	0.10 man-years

Summer Interns

This is an ideal project for Summer Interns with little experience in the established remote sensing practices. It would give them the opportunity to freely explore any approaches that might come to their minds.